To measure the extent of endotracheal tube migration after placement of patient in optimal surgical position for primary head and neck onco-surgeries: A prospective, observational study.

A thesis submitted to the faculty of

ALL INDIA INSTITUTE OF MEDICAL SCIENCES,

BHOPAL

For the award of the degree of DM in the subject of

Onco-anaesthesiology and Palliative Care

By

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8. Mr. Yogesh Kumar, Executive Director, Samarthan.....Member
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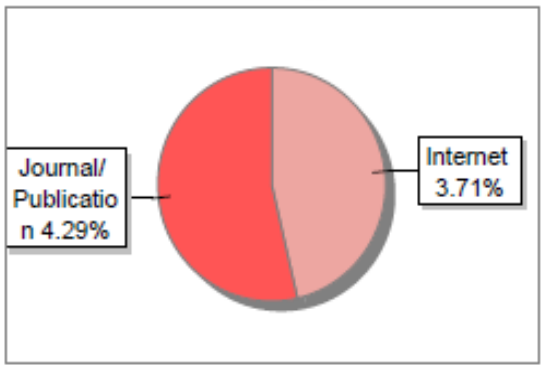

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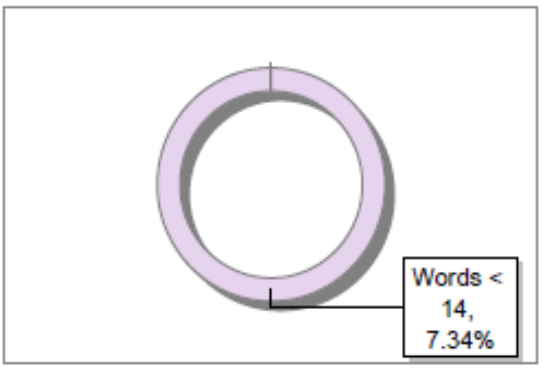

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LIST OF ABBREVIATIONS

ABBREVIATION	EXPANDED FORM
ASA	American Society of Anesthesiologists
BMI	Body mass index
CC	Cricoid cartilage to upper margin of the endotracheal tube cuff
cD	Depth of intubation as per the Chula formula
CI	Confidence Interval
DICOM	Digital Imaging and Communications in Medicine
DM	Intubation depth mark present on the endotracheal tube
eD	Depth of the ETT at the nares after head and neck extension
ETT	Endotracheal tube
eTTCD	ETT Tip to carina distance with head and neck in extension
eVCCD	Vocal cords-carina distance with head and neck in extension
FB	Flexible bronchoscope
Ht	Height
RAE	Ring-Adair-Elwyn
ICU	Intensive care unit
IDM	Intubation depth Mark
IHEC	Institutional Human Ethics Committee
MG	Migration of the ETT at vocal cords with head and neck extension
MSE	Mean squared error
nD	Depth of ETT at nares with head and neck in neutral position
nTTCD	ETT tip to carina distance with head and neck in neutral position

ABBREVIATION	EXPANDED FORM
NT	Nasotracheal
NTI	Nasotracheal intubation
nVCCD	Vocal cords to carina distance with head and neck in neutral position
OR	Operating room
VCD	Vocal cords-carina distance
SN-CA	Sternal notch to carina
SSPS	Statistical Package for Social Sciences
tEL	Tracheal elongation due to head and neck extension
TC	Tip to carina
TMD	Thyromental distance
TTIDM	Distance from ETT tip to intubation depth mark
TTL	Total tracheal length
VC-SN	Vocal cords to sternal notch
Wt	Weight

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ABSTRACT

Introduction: Head and neck extension is required for optimal surgical exposure during oncosurgeries. This was shown to make an endotracheal tube (ETT) too shallow, which may cause vocal cord damage, accidental extubation, etc. In patients with restricted mouth opening, it is challenging to prevent this complication as laryngoscopy may not be possible.

Aims and objectives: Our aim was to estimate the movement of the nasotracheal tube with head and neck extension in adult patients undergoing head and neck onco-surgeries. Our primary objective was to measure, using a flexible bronchoscope, the displacement of the nasotracheal tube at vocal cords when the head and neck was extended in adult patients with restricted mouth opening (<1.5 cm) undergoing head and neck onco-surgeries.

Methods: After placing the ETT via the nose, a flexible bronchoscope was introduced via the other nostril and maneuvered to reach the glottis to ensure the black intubation depth marker aligned with vocal cords. In this position, ETT depth at the nose and the tip-carina distance (TCD) were measured. All the above readings were recorded after neck extension as well.

Results: 60 adults (F – 15, M – 45) were recruited. The ETT migrated outward to an extent of 3±3 mm. The mean depth of ETT with head and neck in neutral and extended positions while maintaining a 3 cm safe distance between the vocal cords and proximal cuff of the ETT was 26.2 ± 1.6 and 26.5 ± 1.6 cm respectively. The mean in increase in vocal cord-carina distance was 1.7 ± 0.6 cm.

Conclusion: The outward migration of the ETT at vocal cords was minimal compared to the outward migration of the ETT tip from the carina with head and neck extension.

INTRODUCTION

Nasotracheal intubation (NTI) is commonly performed in patients undergoing head and neck oncosurgeries for neoplasms of the oral cavity, oropharynx, or tumors of the pharynx. To optimize surgical exposure, head and neck movement is unavoidable during these procedures. This positioning may be necessary for extended periods of time, and the endotracheal tube (ETT) may become displaced as a result of such maneuvers.

A malpositioned tube can cause endobronchial intubation if too deep or can lead to accidental extubation, glottic edema, laryngeal injury, and vocal cord damage if too shallow.[1,2] Furthermore, this displacement could also cause air leakage during mechanical ventilation, leakage of oropharynx secretions, and entry of blood from the surgical field into the airway.[3] ETT depth is affected by changes in the position of the head and neck. As a result, the depth should be modified based on the operative position.

In order to avoid complications of excessively shallow intubation, prior research has suggested that the proximal cuffs of the ETT should be placed >2 cm[4,5] or at 3 cm[6] below the vocal cords. The region between 6 and 10 mm beneath the posterior end of the free edge of the vocal cords is where the anterior branch of the recurrent laryngeal nerve is most susceptible.[7] Additionally, an ideal ETT placement should ensure a 2 to 5 cm distance between the ETT tip and the carina.[4]

The increase in ETT tip-carina distance in adults with head and neck extension has been reported to range from a mean of 0.6 cm[8,9] to a mean of 2.7 cm.[10] This increase is attributed to the lengthening of the trachea and proximal migration of the ETT due to head and neck extension.[11]

In head and neck cancer patients with reduced mouth opening (less than 1 finger breadth/1.5 cm) planned for cancer resection surgeries, there are at least two challenges with respect to airway management. First, the optimal placement of the nasotracheal tube

(NT) so that adequate distance is ensured between the vocal cords and the proximal cuff of the ETT. Second, estimate the outward migration of the ETT at vocal cords so that the ETT depth may be readjusted after assuming optimal surgical positioning.

Various techniques have been described to confirm the depth of ETT placement. The majority of adult ETTs have either a one-centimeter-wide mark at 2-3 cm above the cuff or two black insertion guidance marks at 2 and 4 cm above the cuff.[6] The depth guidance mark alignment with the vocal cords aids in positioning the ETT at the proper depth.[8] However, this technique relies on visualizing the vocal cords with a laryngoscope, which is difficult in patients with large tongue, prominent teeth, and short neck.[12] Furthermore, vocal cords cannot be seen in situations with limited mouth opening and in specific conditions, such as when performing blind intubation or using a Shikani or Bonfil optical stylet to guide intubation.[12]

Another conventional method is where a nasotracheal tube is advanced until the cuff is at least 2 centimeters below the vocal cords[13] or until the external markings are 24 cm for females and 26 cm for males (3 cm more than the oral tube) at the nares.[14] There have been several formulas proposed for estimating the optimal depth of nasally placed tracheal tubes for different ethnic populations.[15-17] The Chula formula was used to calculate the length of ETT at the right external naris = 9 + (body height/10) cm.[15] It predicted the proper length of nasotracheal intubation in 93 of 100 patients belonging to Asian ethnicity. However, in the remaining 7 individuals, the ETT was excessively shallow (less than 2 cm between the vocal cords and the ETT cuff), indicating that formula-derived approaches for determining ETT depth have limitations. The use of ultrasonography to locate the ETT cuff in the airway has also been described by various researchers.[18-20] Ultrasonography can be performed in real-time, is non-invasive, and does not require irradiation. Replacing air with saline in the ETT cuff makes it easier to determine the tube and cuff positions under ultrasound.[18]

Therefore, ultrasonography can be used to evaluate the movement of the ETT cuff with respect to laryngeal structures. However, ultrasound imaging of vocal cord structures and the ETT cuff takes much practice, and it was not able to produce adequate images in some subsets of patients, such as those with prominent Adam's apple or those with neck masses, etc.[12]

Although some studies used a Flexible Bronchoscope (FB), introduced through the lumen of an ETT to ensure that the ETT cuff was 2-3 cm below the vocal cords,[4,15] when the ETT was already in place, it was difficult to detect and visualize the cuff and the vocal cords by using FB, particularly in flexo metallic tubes and silicon Ring-Adair-Elwyn (RAE) tubes due to their opaque nature. Examining the FB through the ETT will indicate where the ETT tip is in relation to the carina, but it does not indicate the proximity of the cuff to the vocal cords.[6]

As mentioned earlier, head and neck extension increases the distance between the ETT tip and the carina. This increase is attributed to the outward migration of the ETT and to the tracheal elongation. However, no study has determined the relative contribution of each component to this increase. This is clinically very important as an already shallow ETT in a neutral position may become overly shallow with neck extension.

In this novel study, we examined the appropriate depth of the nasotracheal tube and the degree of ETT migration (owing to head and neck extension) at the vocal cords in oncosurgical patients with restricted mouth opening in real-time. This was accomplished by using FB, albeit in an unconventional manner. We found that after the ETT was placed via one of the nostrils, the FB may be introduced through the free nostril, and navigated to reach the glottis to visualize the black intubation depth mark (IDM) even in patients with no mouth opening. Thus, this technique may provide a safe distance between the vocal cords and the ETT cuff. We also ensured adequate distance between the ETT tip and the

carina by advancing the FB through the lumen of the ETT. To our knowledge, this is the first attempt to measure the magnitude of displacement of ETT at vocal cords due to head and neck extension using FB passed through the free nostril.

REVIEW OF LITERATURE

In **1976 Conrardy and co-workers**[5] conducted a study in twenty adult patients requiring endotracheal intubation for ventilatory support. Standardized anterior-posterior chest roentgenograms were obtained with the neck in flexed, neutral, and extended position. Movement of the ETT tip relative to the carina was measured from each roentgenogram. They noted that the ETT moved a similar distance regardless of the route of intubation or the inflation status of the cuff. The tube moved an average of 1.9 cm toward the carina with flexion from a neutral position, 1.9 cm away from the carina with extension, and 0.7 cm away with lateral head rotation. Therefore malposition of the ETT may result from changes in head position. To minimize the possible injuries and effects of malposition, they recommended that the tip of the ET tube be placed in the middle 1/3rd of the trachea with the neck in a neutral position.

In **1985, Cavo**[7] conducted a study where a series of ten laryngeal dissections were done and showed the probable site of injury to the recurrent laryngeal nerve, to be located in the subglottic region. The anterior branch of the nerve is vulnerable to compression between an expanded cuff and the overlying thyroid cartilage as it sits atop the superior-anterior border of the posterior cricoarytenoid muscle, about 6-10mm below the posterior third of the true vocal cord. Their study demonstrated the importance of proper tube placement and further stated that ensuring the tube depth marker at 1.5 cm above the upper end of the cuff and placing it at the level of the true vocal cord at the time of intubation prevents complications. They also stated that once the tube has been placed in this position, standard precautions should be taken to prevent tube migration during surgical procedures.

In **1991, Mehta et al**,[21] conducted a study on 140 adult patients using either Teleflex or Portex tracheal tubes. Guide marks were printed at variable distances proximal to the

endotracheal tube cuffs, and during intubation, the guide mark was positioned at the level of the vocal cords. The distance between the bevel end of the tube and the carina was determined with a fibreoptic bronchoscope. The mean distance between the tip of the tracheal tube and the carina varied between 3.7 and 4.1 cm with the head in the neutral position. The tip of the tracheal tube approached the carina by a mean distance of 0.5 cm when the head was moved from the extended position to the neutral position. They recommended that a guide mark be placed 2.5 cm from the proximal end of the cuff in tubes used for adult males and 2.25 cm in tubes used for adult females. They stated that this will still allow the cuff to lie in the trachea and prevent vocal cord paralysis due to compression and the use of guide marks is a simple, safe, and reliable method for correct tracheal tube placement. The limitation of their study was that it could only be used when the vocal cords were visible at intubation.

In **1995, R. Hartrey et al**[6] enrolled 20 ASA 1 and 2 patients. They were intubated with an oral and nasal cuffed tracheal tube. An FB was used to measure tube movement when the position of the head and neck changed. With head and neck flexion, oral and nasal tubes moved an average of l5 mm towards the carina and 8.5 mm away with head and neck extension. With the lateral rotation of the head, movement can occur in both directions. Their findings show that a single guide mark placed 3 cm proximal to the cuff and 8 cm proximal to the distal end would help proper tracheal tube placement, reducing complications caused by this movement. They also state that there is much variation in patients, and the association between a person's height and the length of their trachea has been demonstrated to be weak. As a result, they concluded that employing a 3 cm guide mark is a better method in women than inserting a tracheal tube of a predetermined length measured from the lips or nares.

1n **1997, Reed et al.**,[14] conducted a study in two parts. The first part was a prospective, observational study done to compare the initial depth of NTI, measured at the naris, with the observed height of the ETT tip above the carina on the initial chest radiograph. Gender predicted the optimal depths. In the second part, results from Part 1 were prospectively validated by measuring the frequency of adequate placement when ETTs were placed to this depth. On the chest radiograph, ETT placement was judged appropriate if the tip was at least 2 cm above the carina and below the larynx. They found that twenty-five (96%) of 26 women and 51 (98%) of 52 men had adequate placement. They concluded that initial placement of NTI at 26 cm in women and 28 cm in men, measured at the naris, resulted in adequate initial placement for most adult patients. The study had several important limitations as they noted significant variability in tracheal length, which was presumably related to differences in stature and body habitus, as well as gender. In their study, there was difficulty in visualizing the top of the trachea on the chest radiograph, mandating prudence when performing intubations that result in a high tracheal position. Hence, they suggested clarifying a safe limit for high tracheal positioning would benefit the clinician.

In **2006, Chong and coworkers**[22] attempted to compare vocal cords–carina distance (VCD) in Chinese patients with the dimensions of the distal ends of five commonly used tracheal tubes. In addition, they also attempted to find a surface anatomy measurement that would identify patients with 'short tracheas'. They measured VCD in 130 anesthetized Chinese patients with an FB. They found that VCD averaged 12.6 ± 1.4 cm. In seven patients (5%), this distance was particularly short (between 8.8 and 10.4 cm). Many commonly used tracheal tubes would be either placed close to or beyond the carina when the black intubation guide mark(s) is (are) at the level of the vocal cords. The VCD of <11 cm (short trachea) could be predicted by a patient height of <167.5 cm and a thyrosternal distance (distance between thyroid notch

and xiphisternum) of <28.5 cm with limited reliability. They concluded that many patients with short VCD in their study group could be at risk of endobronchial intubation with many of the tracheal tubes. Patient height and thyrosternal distance can be useful in predicting short tracheas. They further recommended that distance markers be placed at 2 and 4 cm from the proximal end of the cuff. These two marks cover the range previous authors have recommended for the distance between the tracheal cuff and the vocal cords. They noted that two markings would allow at least one intubation guide mark to be above the vocal cords if the depth of ETT insertion needed to be reassessed.

In **2008, Techanivate et al**,[15] conducted a prospective study of 100 patients (50 males and 50 females) who underwent general anesthesia with nasotracheal intubation (number 8.0 for males and 7.0 for females). The Chula formula was used to calculate the length of the ETT at the right external naris = 9 + (body height/10) cm. After intubation, a fibreoptic bronchoscope was inserted into the ETT to measure the distance from the tip of the ETT to the carina and the distance from the upper border of the cuff of the ETT to the vocal cords. The mean length of the nasotracheal tube at the right external naris calculated by the Chula formula was 25.4 cm in males and 24.4 cm in females. The mean distance from the tip of ETT to the carina was 3.9 cm in males and 3.1 cm in females. The mean distance from the upper border of the cuff of ETT to the vocal cords was 2.6 cm in males and 3.0 cm in females. Ninety-three patients with the upper border of the cuff of ETT had it placed at least 2 cm below the vocal cords, and in seven patients, the distance from the tip of ETT to the carina was found to be 1 to 1.9 cm. In every patient, they found that the tip of ETT was placed at least 2 cm cephalad to the carina. They concluded that the Chula formula could be used to predict the proper length of nasotracheal intubation in 93 of 100 patients. The authors also suggested that the patients who were short and had short trachea should be intubated by a shorter distance from the upper

border of the cuff to the tip of the ETT, which decreases the risk of vocal cord injury when they extend the heads. One limitation of the Chula formula was that in the patients who do not know their height, the proper length of the ETT cannot be calculated.

In **2008, Wong et al**[23] conducted a study to estimate the lengths of the three airway segments from the upper incisors to the carina in three different neck positions in intubated patients. Twenty elective surgery patients were investigated. The airway was divided into three segments: upper incisor to vocal cords (UI-VC), vocal cords to sternal notch (VC-SN), and sternal notch to the carina (SN-CA). A bronchoscope was inserted through a ported elbow adapter until the tip contacted the carina. A marker tape was placed on the bronchoscope immediately above the adapter port. As the bronchoscope was withdrawn to the sternal notch (by transillumination), vocal cords, and upper incisor (endoscopic visualization),
three corresponding markers were placed along the bronchoscope. The three airway segments were obtained by measuring the distances between the four markers. Measurements were taken with the patient's neck in flexion (10 cm pillow), neutral (5 cm pillow), and extension (no pillow) positions. They found that the UI-CA increased by 1.99 ± 0.70 cm ($P < 0.001$). SN-CA represented 64%, 61%, and 56% of the VC-CA distance with the neck in flexion, neutral, and extension, respectively. SN-CA did not change significantly among the head positions (NS). From neck flexion to extension, the UI-CA distance increased by 1.99 cm. The major contribution to this lengthening was an increase of the VC-SN distance by 1.74 cm; UI-VC increased by 0.36 cm, whereas SN-CA did not change significantly. Averaging the three neck positions, the SN-CA distance represented 60% of the tracheal length, suggesting that it may not be located at the midpoint of the trachea. The study had limitations. The study's subject population was small, and type II errors were conceivable. Also, transillumination of the sternal

notch using bronchoscopy may not be usable in obese subjects or patients with thickened neck soft tissue.

In **2015, Tailleur et al**[24] conducted an observational clinical trial where they measured the change in distance between the ETT tip and the carina, using a fiberscope through the ETT. They found that after intubation, a wide disparity of tube tip distance to the carina in the neutral position was noted with a median of 5.0 (3.5-7.0) cm. The tube excursions were defined as subtracting the distance from the ETT tip to the carina, for the different movements, and its position in a neutral situation. Cephalad tube movement was documented following maximal head and neck extension in 34 (68%) patients and right head rotation in 25 patients (50%). Caudal tube displacement was due to maximal head and neck flexion in 38 patients (76%) and left head rotation in 25 patients (50%). Selective right main bronchus intubation was noted in 2 (4%) patients after maximal head extension. They concluded that maximal head and neck movements led to unpredictable tube displacements and stated that proper reassessment of tube positioning after head and neck movement of intubated patients is therefore mandatory. They further stated that studies in different settings will be necessary to better assess tube tip displacement according to maximal head and neck movements.

In **2017, Herway et al,**[11] conducted a review to, first, determine the static factors that affect the length of the human trachea across different populations and, second, to investigate whether or not there are dynamic factors that cause the length of the human trachea to vary within the same individual. They found that gender, extremes of age, patient height, postsurgical changes, and co-existing disease are static patient factors that affect the length of the human trachea. Under anaesthesia, dynamic clinical changes such as Trendelenburg posture, head and neck flexion, extension, and diaphragm and pneumoperitoneum paralysis

lead the trachea to behave as an accordion, reducing and increasing in length. The length of the human trachea in awake, anesthetized, and paralyzed individuals is a crucial consideration in avoiding both endobronchial intubation and tracheal extubation. They stated that the dynamic clinical changes that occur under anesthesia, the trachea would act as an accordion, decreasing and increasing its length within the same individual, and understanding this is an essential clinical aspect is understanding the amount of the change in tracheal dimensions in response to these conditions.

In **2017, Ji et al,**[16] conducted a study with the aim of estimating the optimal depth of nasotracheal tube placement. They included 110 patients scheduled to undergo oral and maxillofacial surgery, requiring nasotracheal intubation. The initial ETT placement and positioning were confirmed on clinical assessment by cuff palpation at the sternal notch. The position of the tip of the ETT was confirmed by fiberoptic bronchoscopy and placed 3 cm above the carina. After confirming position, the depth of tube placement was measured using the centimeter markings printed on the tube. The neck circumference and distances from nares to tragus, tragus to angle of the mandible, and angle of the mandible to sternal notch were measured. All measurements were carried out with the head in the neutral position. They devised the following formula for estimating tube depth: 19.856 + 0.267 × sum of the three distances. They concluded that the optimal tube depth for NTI in adult patients correlated with height and sum of the distances from nares to tragus, tragus to angle of the mandible, and angle of the mandible to sternal notch, and the proposed equation would be a useful guide to determine optimal nasotracheal tube placement. The study has several limitations, with the preformed curvature of the RAE tube that was used, the ability to adjust the intubation depth is limited. Moreover, since the length from the tip of the ETT to the mark is constant, it is difficult to individualize tube depth. Secondly, as the study is based on anthropometric

measurements of, adult, Korean patients, a larger sample size would be necessary to apply it to different populations. The portex RAE nasal ETT is made of silicone and has an opaque surface; besides, depth measurements are not marked, which can have an effect on the accuracy of their measurements. Third, all measurements were made with the head in the neutral position. They suggested that if the head position changes during surgery, the tube depth should be adjusted accordingly to account for the changes, as any unrecognized malposition of the endotracheal tube can lead to severe complications in patients under general anesthesia.

A prospective case-control study was conducted in **2018, by Chen *et al***[12] to verify the feasibility of using ultrasound to measure the distance between the upper edge of a saline-inflated cuff and the vocal cords. 105 adult patients who required general anesthesia were enrolled. Ultrasound was used to identify the position of the vocal cords before induction. After intubation, the ETT was fixed at a depth of 23 cm at the upper incisors in men and 21 cm in women, and the depth of intubation was verified by video-assisted laryngoscopy. The distance between the upper edge of the saline-inflated cuff and the vocal cords was measured by ultrasound; the ideal distance was considered 1.9–4.1 cm. They noted that among the 105 cases, two cuffs were too close to the vocal cords and one too far away from the vocal cords. The diagnosis was made by ultrasound and was in agreement with results from direct laryngoscopy. They stated in their study that the overall accuracy of ultrasound in identifying malposition of the cuff was 100.0% (95% CI: 96.6% to 100%), and this can be used as a reliable method to avoid malposition of the ETT cuff and reduce the incidence of vocal cords injury after intubation. There are several limitations to this study. Patients with difficult airways (Mallampati classification 3 and 4, mouth opening 3 cm) were excluded. It is especially crucial to research shallow intubation in these patients since they have the highest risk of complications. In some male patients with prominent Adam's apple, the probe could not be

fully attached to the skin and the vocal cords could not be completely seen and in some cases, unsatisfactory ultrasound images of the glottis were obtained. Although too-shallow intubation was avoided using this method, too-deep intubation cannot be prevented at the same time. Even for experienced anesthesiologists, it took 5–8 min to complete the whole examination procedure, and training is needed for inexperienced anesthesiologists.

In **2019, Yao et al.,** [17] estimated the appropriate tubing depth for fixation to prevent inadvertent endobronchial intubation and prolapse of the cuff from the vocal cord. On cephalometric radiographs, they assessed the anatomical length of the upper airway tract via the oral and nasal channels as follows: the oral upper airway tract was measured from the tip of the incisors to the arytenoid cartilage (to which the vocal cords attach) through the hard palate, the soft palate, and the palatine uvula, and the nasal upper-airway tract was measured from the tip of the nostrils to the arytenoid cartilage through the concha nasalis media and the posterior wall of the pharynx. They set measurement markers on the route of intubation tubing and measured the tract using a DICOM viewer. Then, they examined whether the length of the pathway was correlated with the height of the patient measured before the operation and developed estimation formulas using (patient height/10) + an integer (in cm). By considering the length of the intubation marker of each product (DM), they proposed the length of tube fixation as (height/10) + 1+ DM for nasal intubation and (height/10) – 3 + DM for oral intubation. They concluded that the formulae were within almost 1 cm error in most cases. Their study had some limitations as the study was limited to adults, and formula cannot be used for pediatric patients. The study was performed retrospectively; thus, the optimal tube length could not be confirmed during surgery. They stated that a prospective study be conducted to check the suitability of the proposed formula, and that more research be conducted to corroborate their findings.

In **2019, Lee et al.,**[25] investigated whether nasotracheal (NT) tubes were appropriately used in terms of size and depth in adult patients. They sized the nares in 40 patients using standard nasopharyngeal airways (6.0–8.0) before elective surgery under general anesthesia. The largest size nasopharyngeal airway that passed easily into the nasopharynx without resistance was considered an appropriate size. Using a fibreoptic scope, they measured distances from the nares to the vocal cords and the nares to the carina. Rates of proper NT tube positioning were calculated with regard to the cuff and distal tip. They found that the most frequent sizes of properly fitted NT tubes were 6.5 and 6.0 in male and female patients, respectively. Positioning of the cuff and distal tip was only appropriate when using a properly sized tube in 26% and 47% of male and female patients, respectively. They found that after inserting an NT tube, attention should be given to assessing the insertion depth when using an NT tube that has been sized to fit the nostril. They investigated whether properly sized NT tubes can reach appropriate depths relative to the proximal cuff. Their findings indicated that the proximal cuff was positioned too close to the vocal cords, which created the potential for cord damage or accidental extubation when a properly sized NT tube was fixed as intended. They proposed a new perspective on the design and production of NT tubes that offer variability in length and caliber. There were a few limitations to the study as the sample size was small. Additionally, subjectivity was involved in gauging the ease of, or resistance to, passage of the NT tube. They suggested that NT tubes of the same diameter may need to be available in various lengths to accommodate the nostril size and airway length to ensure optimal placement.

Complications of the endotracheal tube (ETT) displacement during head and neck positional changes are related to not only the tip position but also the cuff pressure against the larynx. In **2023, Kang and coworkers**[26] evaluated the movement of the ETT cuff relative to

laryngeal structures as well as tip displacement from the carina. Sixty-two patients scheduled for thyroidectomy were recruited in a prospective observational study. The endotracheal tube was advanced so the vocal cords were positioned between two marks on the tube. The distance from the cricoid cartilage to the upper margin of the cuff (CC) and from the ETT tip to the carina (TC) were measured using ultrasonography and fiberoptic bronchoscopy, respectively, during flexion and extension. The total tracheal length (TTL) was defined as the combination of CC, TC, and the distance from the upper margin of the cuff to the tip. During flexion, the CC and TC were 1.5 ± 0.6 and 2.9 ± 1.0 cm respectively. Seven patients (11.7%) exhibited excessively deep intubation. After adjusting the cuff position under ultrasonography (CC = 0), the tip position was corrected in 96.7%. While the TC increased by 2.1 ± 1.0 cm after the positional change in extension, the CC decreased by 0.6 ± 0.7 cm because the TTL lengthened (1.4 ± 1.1 cm). Four patients (6.7%) exhibited excessive cuff displacement beyond the cricoid cartilage upon positional change, which could have been corrected under ultrasonography. They concluded that the ETT cuff displaced toward the larynx in a lesser degree than the tip did from the carina due to the tracheal lengthening during head and neck extension. They suggested that the position of the upper edge of the saline-inflated cuff relative to the cricoid cartilage should be assessed ultrasonographically to avoid ETT malpositioning and reduce the risk of laryngeal injury. The limitations of their study were that the ultra-sonographic visualization of the cricoid cartilage and ETT cuff may not be easy in some patients and is highly operator-dependent. Patients with body mass index (BMI) > 30 kg/m², height < 150 cm, predicted difficulty with intubation (Mallampati class ≥ 3 or mouth opening <3 cm) were excluded from the study. The safety of saline for cuff inflation should be considered as the cuff was not designed to be inflated with saline, and the volume used can raise the tracheal mucosal pressure above the upper limit recommended for safe, prolonged endotracheal intubation (30 mm Hg).

AIMS AND OBJECTIVES

AIM

Our aim was to estimate the movement of the nasotracheal tube with head and neck extension in adult patients undergoing head and neck onco-surgeries

OBJECTIVES

PRIMARY OBJECTIVE

Our primary objective was to measure using a flexible bronchoscope the displacement of the nasotracheal tube at vocal cords when the head and neck was extended in adult patients undergoing head and neck onco-surgeries.

SECONDARY OBJECTIVES

1. To measure the depth of ETT at nares while ensuring a 3 cm distance between vocal cords and proximal cuff of ETT with head and neck in neutral position and in neck extension.
2. To measure the length of the vocal cord-carina distance.

MATERIALS AND METHODS

Study site: All India Institute of Medical Sciences, Bhopal, Madhya Pradesh, India

Study period: March 2022 to September 2023

Sample size: 60

Study design: A prospective observational study involving a single group

Setting: Operation theatre of the institute

SAMPLE SIZE

No prior studies measured the magnitude of ETT movement at vocal cords in patients intubated through the nasotracheal route. The sample size required to detect 4.5 mm movement was determined in a pilot study. The minimum needed sample size was 59, based on a statistical power of 95% and an alpha error of 0.05%.

STUDY PARTICIPANTS

Inclusion criteria

All adult patients of both sexes, aged 18-75 years belonging to American Society of Anesthesiologists (ASA) physical status class I-III, undergoing head and neck oncosurgeries who have restricted mouth opening (less than 1.5 cm) requiring awake flexible bronchoscope guided nasotracheal intubation.

Exclusion criteria

1. Patients in whom nasotracheal intubation is contraindicated

2. Patients in whom glottic view is sub-optimal through the opposite nostril

3. Inability to pass flexible bronchoscope through the opposite nostril.

4. Restricted neck extension, defined as neck extension less than 30 degrees

METHODS

After obtaining Institute Hospital Ethics Committee (IHEC) approval (IHEC-PGR/2021/DM-M.ch/Jul/01), and Clinical Trial Registry of India registration (CTRI/2022/04/041671), patients who were willing to participate were handed over a patient information sheet and written informed consent a day prior to the scheduled surgery. A total of 60 patients classified in ASA physical status I-III with restricted mouth opening (mouth opening < 1.5 cm) undergoing head and neck oncosurgeries were recruited for the study.

Pre-anaesthesia check-up

A thorough pre-anesthesia check-up was done for all patients, including history and physical examination. Examination of the airway was undertaken in detail including inter-incisor distance, Mallampati class, thyromental distance, neck movements, and nasal patency. Radiological features of difficult airway such as altered airway anatomy due to tumor infiltration were also noted. Routine and special investigations were done as per the requirement of the case. The tumor stage, anatomical position of the tumor, and history of previous surgery/radiotherapy were also noted. All the patients were prescribed oral alprazolam 0.25 mg the night before surgery and on the morning of the surgery for anxiolysis. Fasting guidelines were as per institutional protocols.

On the day of surgery, airway preparation (airway anaesthesia and nasal decongestion on both sides) was done for all the cases as per discretion of the attending anesthesiologist. In the operating theatre standard anesthesia monitors were attached. After an intravenous (IV) catheter was secured, all patients were administered procedural sedation with dexmedetomidine. The optimal size of ETT was determined after passing incremental size of nasopharyngeal airways prior to intubating with flexometallic endotracheal tube (***Rusch*** ®

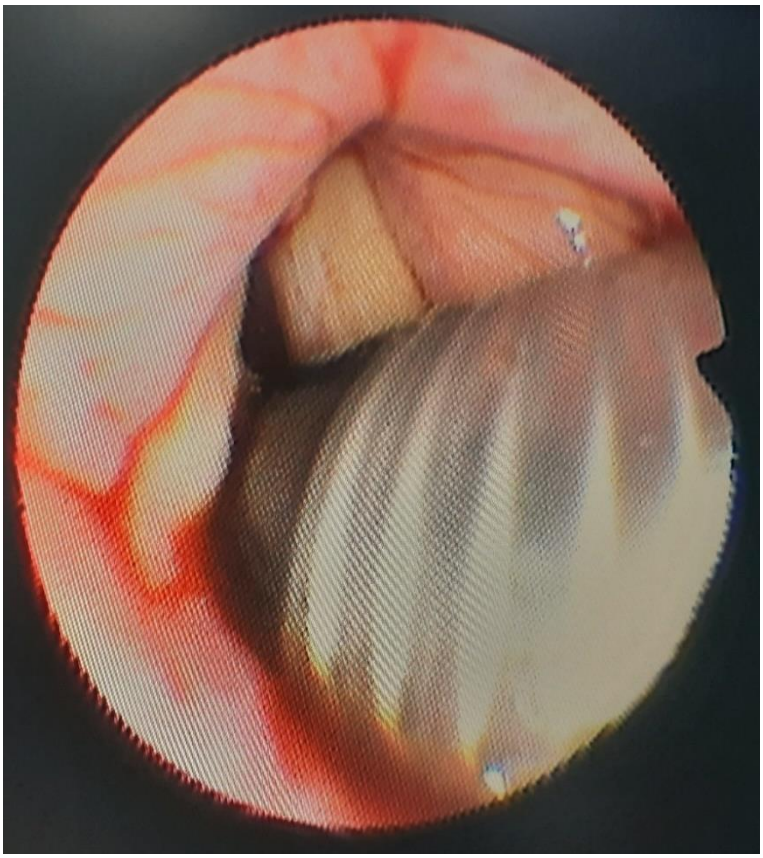
Teleflex Medical, Germany) using a flexible bronchoscope (FB) (***Olympus***; Hamburg, Germany).

<u>Figure 1</u>: Figure depicting the technique of measuring the distance between the black intubation depth mark and the proximal cuff, and to the tip of the ETT. In the 7 sized Rusch ETT, the distances are 3 and 9.5 cm.

The optimal size of the ETT was decided based on the patients' built and the nasal patency after passing serial sizes of the nasopharyngeal airways. The laterality of the endotracheal intubation was decided based on the nasal patency documented by preoperative nasal endoscopy. Before loading the ETT to FB, the distance from the black intubation depth mark (IDM) to the proximal cuff and to the tip of the ETT was recorded using a sterile scale in all cases (**Figure 1**). In all patients, ETT was preliminarily secured at a depth based on the Chula formula[11] intended for nasotracheal intubation. According to the Chula formula, the recommended depth at nares to fix a nasotracheal tube can be obtained by dividing the height of the patient in cm by ten and adding 9 cm to it. For instance, in a patient who is 165 cm tall, as per the Chula formula, the ETT needs to be secured at 25.5 cm. Patients were induced and

paralyzed only after visualizing the tracheal rings through FB and the $EtCO_2$ trace in the monitor. After intubation, a thorough suction of the pharynx was done so that relatively clear vision could be obtained while passing FB through the opposite nostril.

Figure 2: Flexible bronchoscopic view of the glottis in a patient intubated via the right nostril. The FB was advanced through the left nostril and maneuvered to reach the glottis to ensure that the vocal cords align with the black intubation depth mark. At 12 O clock position, the anterior commissure of the vocal cords can be seen. Note: In this image, the ETT was intentionally pulled out to demonstrate the black intubation depth mark.



A standard study protocol was applied as follows:

Step 1: With head and neck in the neutral position, FB was introduced through the opposite nostril (free nostril), and maneuvered to reach the glottis to visualize if the intubation depth mark (IDM) is aligning with vocal cords (**Figure 2**). If the IDM is not aligning with the vocal cords, necessary adjustments were made so as to align IDM with the vocal cords. The mark of the ETT (nD = depth mark at nares with head and neck in neutral position) at nares was noted.

Step 2: Then, the FB was introduced into the lumen of the ETT, and the distance from the ETT tip to the carina (nTTCD) was measured in this position (head and neck in neutral

position). The vocal cords-carina distance in this position (nVCCD) was obtained by the sum of two distances namely, the distance from IDM to ETT tip and the distance from ETT tip to the carina (nTTCD). The tip-carina distance was measured on the FB with the help of two plastic bulldog clamps as shown in **Figure 3**.

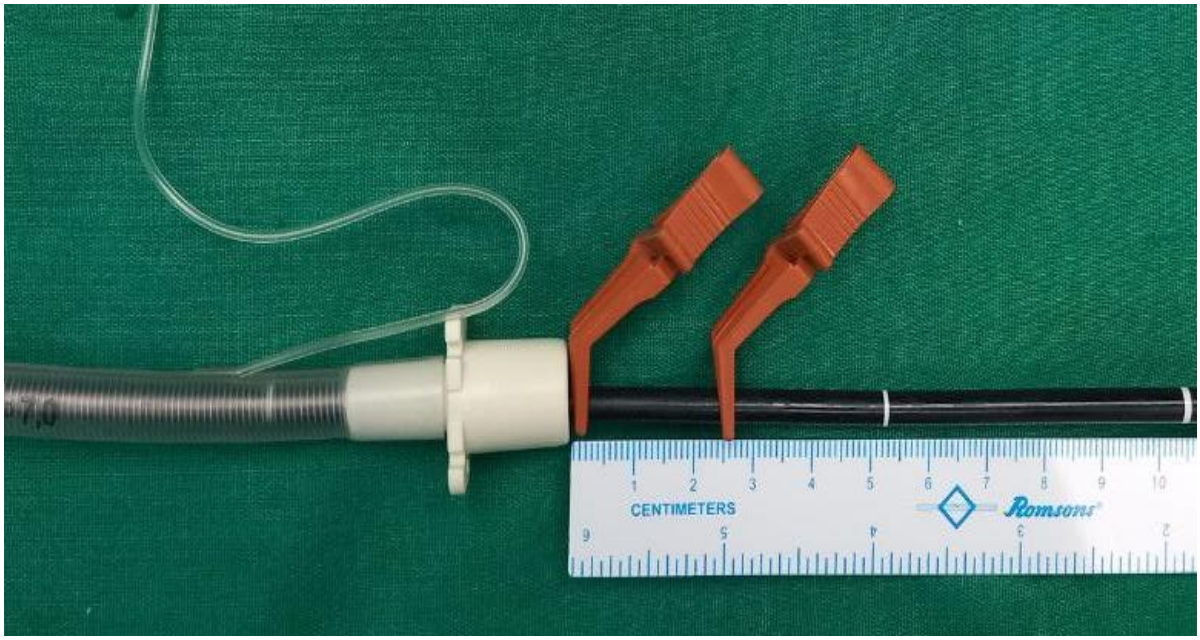


Figure 3: Figure depicting the technique of measuring the ETT tip-carina distance

Step 3: The patient's head and neck was extended using a shoulder roll to achieve a Frankfurt angle of 140-150 degrees (**Figure 4**), measured using a goniometer. The FB was introduced through the free nostril and navigated to reach the glottis to check whether the vocal cords aligned with the IDM. Proximal migration of the ETT was diagnosed by the presence of the IDM above the vocal cords. Now, the ETT was advanced to align vocal cords with IDM to an extent equal to the outward migration (MG). The ETT was secured at this position and the depth was noted (eD) at nares. This new depth was equal to sum of the nD and the MG distances.

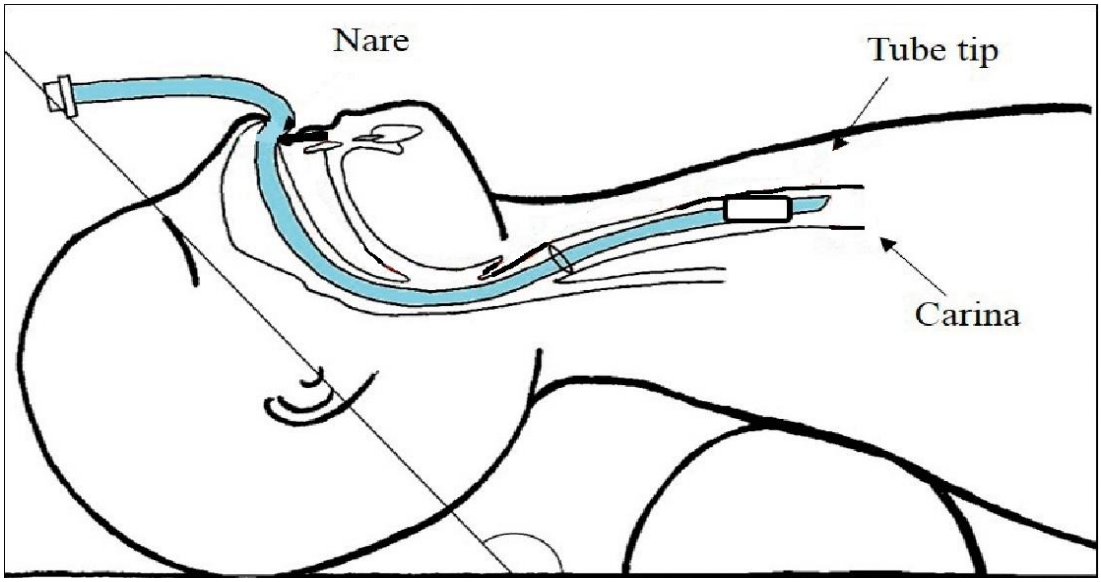


Figure 4: Figure depicting the technique of measuring the angle of head and neck extension. The patient's head and neck is extended to achieve a Frankfurt angle of 140-150 degrees. (Frankfurt angle – The degree of angulation was measured using a line from the external auditory meatus to the superior orbital margin relative to the flat horizontal surface of the OR table)

Step 4: Now, with the head and neck in extension and ensuring the alignment of vocal cords and the IDM, the ETT tip to carina distance was measured (eTTCD). The vocal cord to carina distance (eVCCD) in this position was obtained by the sum of two distances namely, the distance from IDM to ETT tip and the distance from ETT tip to carina (eTTCD).

List of measurements used in the protocol

nD – depth of the ETT at the nares with head and neck in neutral position when vocal cords were aligning with the black intubation depth mark (maintaining 3 cm distance between the vocal cords and the proximal end of the ETT cuff)

nTTCD – ETT tip to carina distance with head and neck in neutral position

nVCCD – vocal cord to carina distance in neutral position

MG – migration of the ETT with head and neck extension

eD – depth of the ETT at the nares after head and neck extension when vocal cords were aligning with the black intubation depth mark (maintaining 3 cm distance between the vocal cords and the proximal end of the ETT cuff)

eTTCD – ETT tip to carina distance with head and neck in extension

eVCCD – vocal cord to carina distance with head and neck in extension

At the end of the surgery, if extubation was not planned, the tube was fixed at a depth (nD) maintaining a 3 cm distance between the proximal cuff and vocal cords with head and neck in neutral position prior to shifting the patient to ICU for elective ventilation.

The observer was the primary investigator. At the end of the study accumulated data was analysed by the observer.

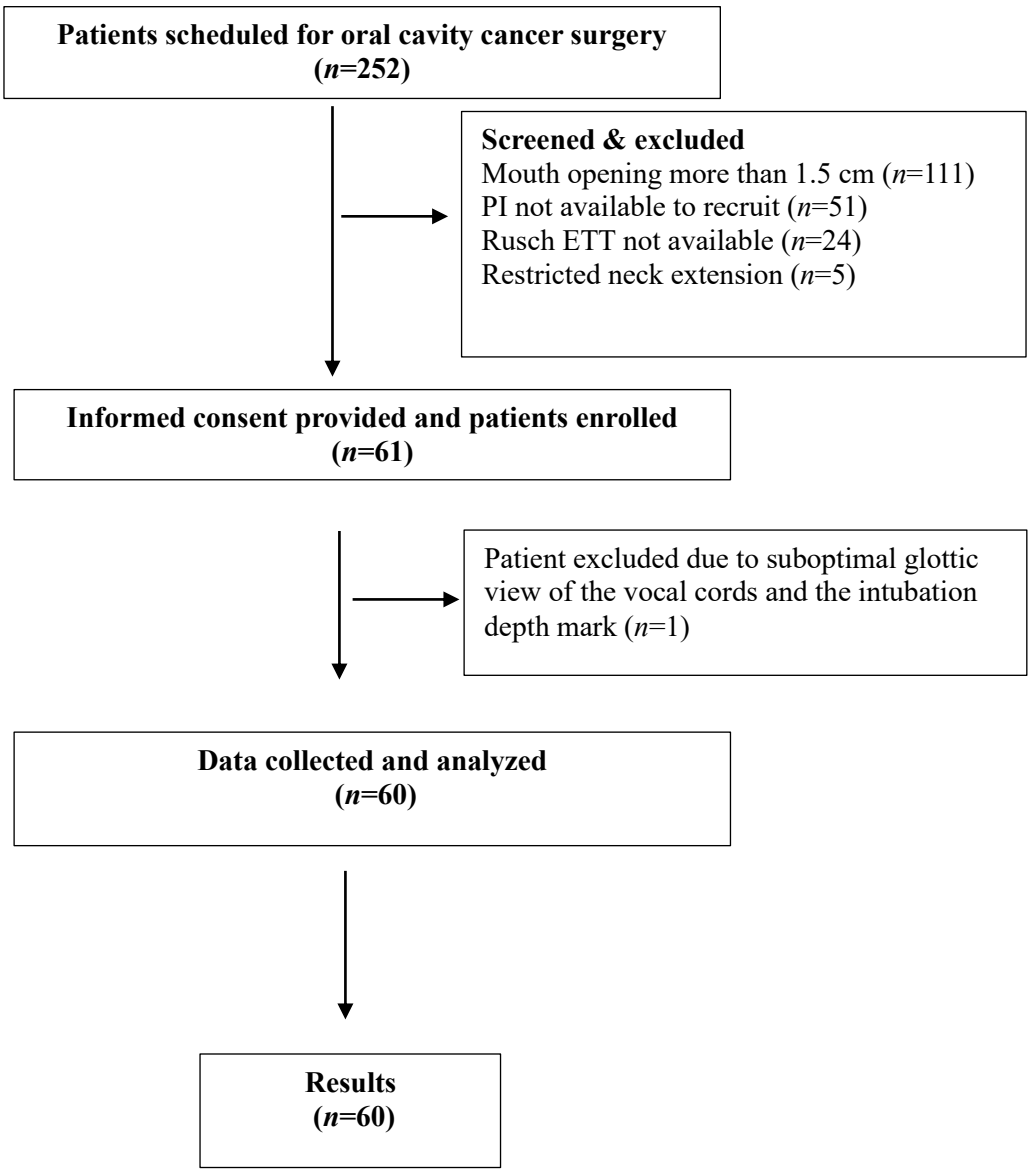
Outcome measures

1) Displacement of endotracheal tube at vocal cords with head and neck extension
2) Depth of ETT at nares with head and neck in neutral position and with extension
3) Length of the trachea with head and neck in the neutral position and with neck extension

Statistical analysis

Statistical analysis was performed by the Statistical Package for Social Sciences (SPSS) program for Windows (version 26; SPSS Inc., Chicago, IL, USA). Continuous variables were presented as mean ± SD, while those with categorical variables were presented as absolute numbers and percentages. The effect of gender, height, thyromental distance, and BMI on ETT migration and tracheal elongation was analyzed using a multiple linear regression model.

FLOW OF PARTICIPANTS THROUGH THE STUDY


Patients scheduled for oral cavity cancer surgery
(n=252)
Screened & excluded
Mouth opening more than 1.5 cm (n=111)
PI not available to recruit (n=51)
Rusch ETT not available (n=24)
Restricted neck extension (n=5)
Informed consent provided and patients enrolled
(n=61)
Patient excluded due to suboptimal glottic view of the vocal cords and the intubation depth mark (n=1)
Data collected and analyzed
(n=60)
Results
(n=60)

RESULTS

A total of 60 patients in the age group of 18-75 years undergoing primary oral cavity cancer surgery were enrolled over 18 months in this prospective observational study.

DEMOGRAPHIC DATA

I. Age distribution of the study population

The youngest patient was a 28-year-old male and the oldest patient was a 74-year-old male. The mean age of the population was 47.3 ± 10.7 years. The age distribution of the study population is represented in **Figure 5**.

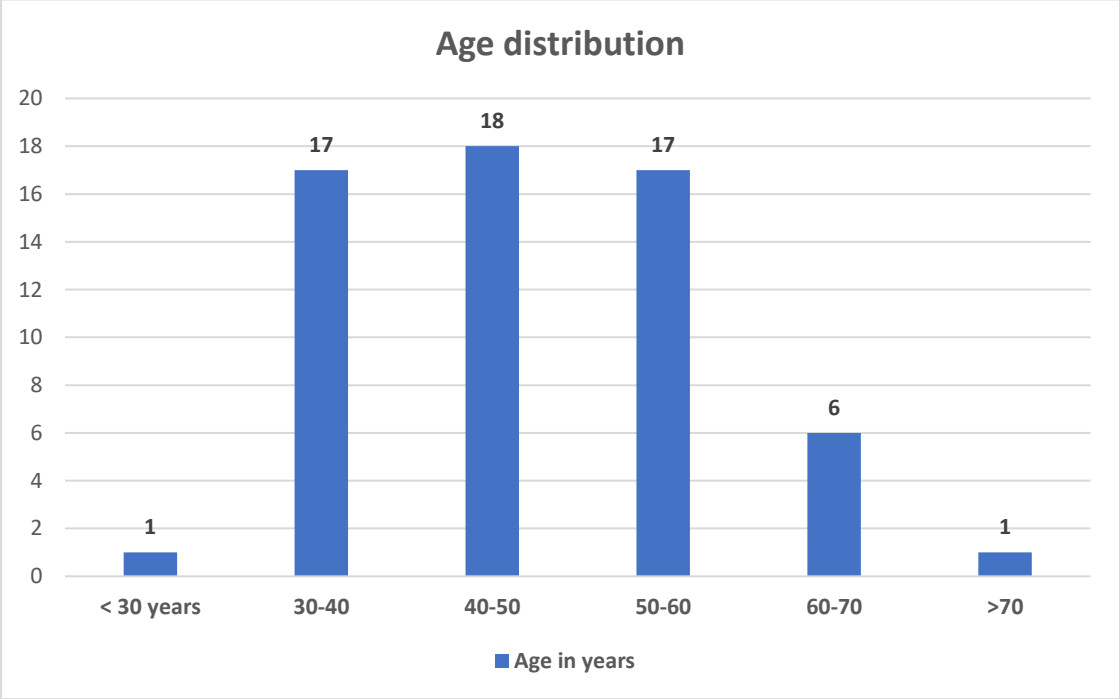


Figure 5: Age distribution of the study population

II. Gender distribution of the study population

Out of the 60 patients in the study population, 25% are females (*n*=15) and 75% are males (*n*=45) represented in **Figure 6.** The higher incidence of the male population in our study was due to a higher incidence of tobacco chewing in males than females.

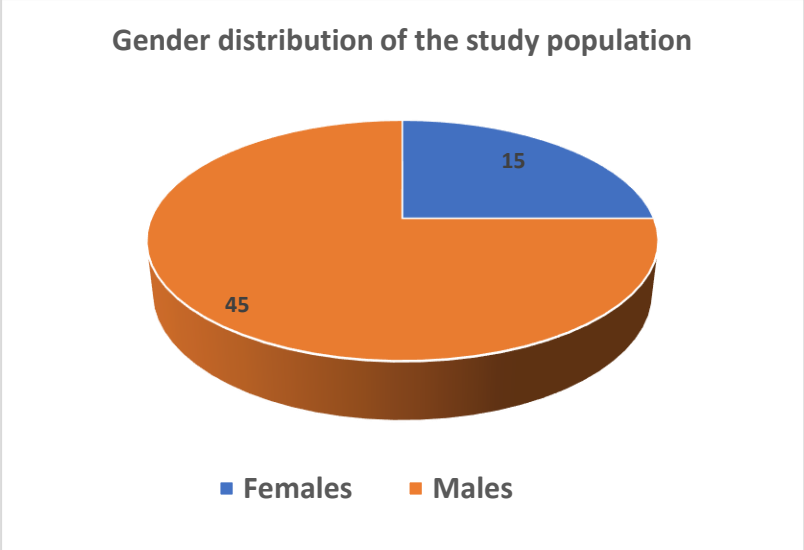


Figure 6: Gender distribution of the study population

III. Weight, height, and body mass index distribution of the study population

The mean height, weight, and body mass index (BMI) distribution of the study population is described in **Table 1**.

Parameter	Mean	Standard deviation
Weight (in Kg)	58.9	7.2
Height (in cm)	164.9	8.4
Body mass index (kg/cm^2)	21.7	2.5

Table 1: Height, weight, and BMI distribution of the study population

CLINICAL CHARACTERISTICS OF THE STUDY POPULATION

I. American Society of Anaesthesiologists (ASA) physical status

Out of 60 patients, 32 patients belonged to ASA class I, 24 patients belonged to ASA class II and 4 patients belonged to ASA class III.

II. Laterality of the tumor

Out of the 60 patients, 28 patients have oral carcinoma on the left side and 32 patients have oral carcinoma on the right side.

AIRWAY PARAMETERS

I. Mouth opening

We recruited the patients with mouth opening less than or equal to 1.5 cm. The mean mouth opening (MO) of the patients was 1.3 ± 0.2 cm.

II. Thyromental distance (TMD) of the patients

The mean thyromental distance (TMD) of the patients was 7.1 ± 0.4 cm.

III. Side of the nasotracheal intubation

Out of the 60 patients, 37 patients had nasotracheal intubation through the right nostril, and 23 patients were intubated through the left nostril. The side of the nasotracheal intubation was decided based on the most patent nostril obtained by preoperative nasal endoscopy.

IV. Size of the endotracheal tubes used for intubation

The distribution of the endotracheal tube (ETT) sizes is depicted in Table 3. Most of the patients (96.6%) in our study were intubated using 6, 6.5, or 7-sized endotracheal tubes.

V. Distance between the intubation depth mark (IDM) and the endotracheal tube tip

All 60 patients were intubated with the 5 different sizes of Rusch (Teleflex Medical, Germany) endotracheal tubes. The distance between the intubation depth mark and the endotracheal tube tip (**Figure 1**) is described in **Table 2**. All 5 sizes of the Rusch endotracheal tubes have a 3 cm distance between the IDM and the proximal end of the ETT cuff. **(Figure 1**)

Size of the ETT (internal diameter in mm)	6	6.5	7	7.5	8
No of patients	1	18	21	19	1
IDM to ETT tip distance (cm)	8.5	9	9.5	10	10

Table 2: Endotracheal tube characteristics

VI. Depth of the endotracheal tube at nares

After intubation, the endotracheal tube was preliminarily secured at a depth derived from the Chula formula.[15]

Chula formula for nasotracheal tube fixation (cm) = (height of patient in cm/10) + 9

As per the Chula formula, the mean depth of fixation of the nasotracheal tube was 25.5 ± 0.8 cm. The ETT depth (**Table 3**) was later adjusted so that with the head and neck in a neutral position, the IDM aligns with the vocal cords. With head and neck in extension, the ETT was finally secured at a depth when the IDM aligned with the vocal cords. (**Table 3**). The mean depth of fixation of the ETT by the Chula formula was lesser when compared to the mean depth of fixation with the patient's head and neck in the neutral position. As expected, the mean depth of fixation with patients' head and neck extended is more than that of neutral head and neck position.

VII. Outward migration of the endotracheal tube

On average, the endotracheal tube migrated outward by 3 ± 0.3 mm due to head and neck extension. In the majority of the patients, the movement was less than 5 mm, whereas in only 3 patients, the movement exceeded 5 mm. In 19 patients, the ETT did not migrate due to head and neck extension.

VIII. Endotracheal tip to carina distance and vocal cord to carina distance

The endotracheal tip-carina distance and the vocal cord-carina distances were measured with head & and neck in the neutral position and with the head & and neck in extension. As expected both the distances increased with head and neck extension. This increase is due to tracheal elongation as outward migration of the ETT due to head and neck extension was corrected by advancing the ETT so that vocal cords align with the IDM even when the head and neck were extended. All the aforementioned measurements are described in **Table no 3.**

S. no		**With head and neck in the neutral position**	**With head and neck extension**
1.	The mean depth of the ETT at nares when vocal cords align with IDM	26.2 ± 1.6 cm	26.5 ± 1.6 cm
2.	ETT tip to carina distance	2.6 ± 1.0 cm	4.3 ± 1.0 cm
4.	Vocal cords to Carina distance	12.1 ± 1.0 cm	13.8 ± 1.1
5.	Outward migration of the ETT due to head and neck extension	3 ± 0.3 mm	
6.	Tracheal elongation due to head and neck extension	1.7 ± 0.6 cm	

Table 3: Measurement of airway parameters

IX. Multiple linear regression analysis

We have performed a multiple linear regression analysis **(Figures 7 and 8)** to model and quantify the relationship between migration of the ETT, tracheal elongation, and multiple independent variables of gender, height, BMI, and thyromental distance. We first normalized the continuous variables of height, BMI, and TMD of the individual, and transformed the categorical variable of gender by performing One-Hot encoding. We split our observations, consisting of 60 individuals, into training (48 individuals) and testing (12 individuals) sets. This allows for model training on the training set and evaluation on the testing set, helping to assess model performance. We evaluate the model performance using Mean Square Error (MSE) and R-squared. We also produced a scatter plot to visualize the relationship between actual values and predicted values on the test set. The red dashed line represents the ideal line where the predicted values perfectly match the actual values.

Based on the MSE and R-squared, we find that the chosen independent variables do not have a meaningful relationship with the dependent variable, or that the independent variables are correlated with each other.

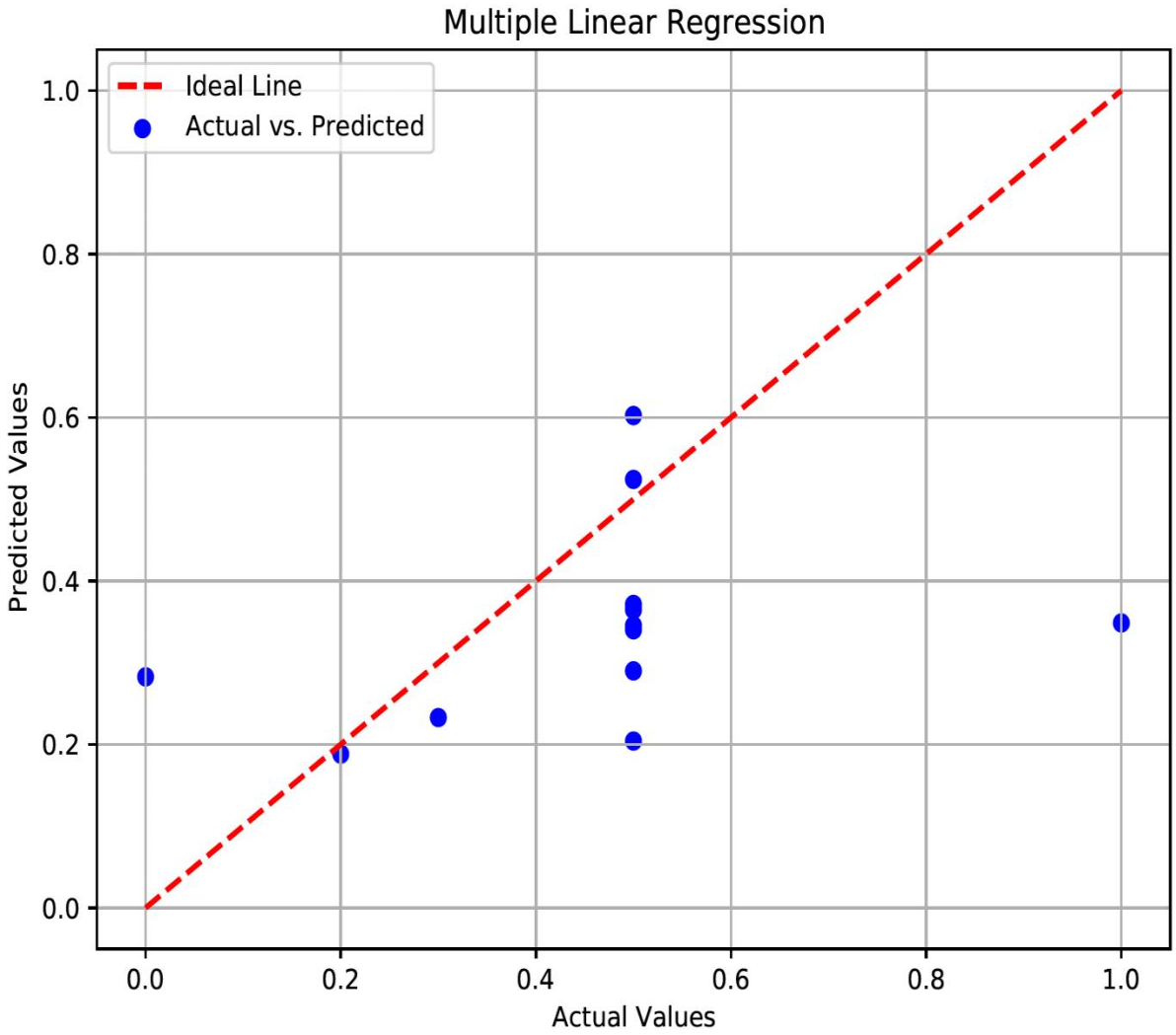


Figure 7: Multiple linear regression showing the relationship between gender, height, BMI, thyromental distance, and endotracheal tube migration. Actual versus predicted has no relationship with the ideal line (red line)

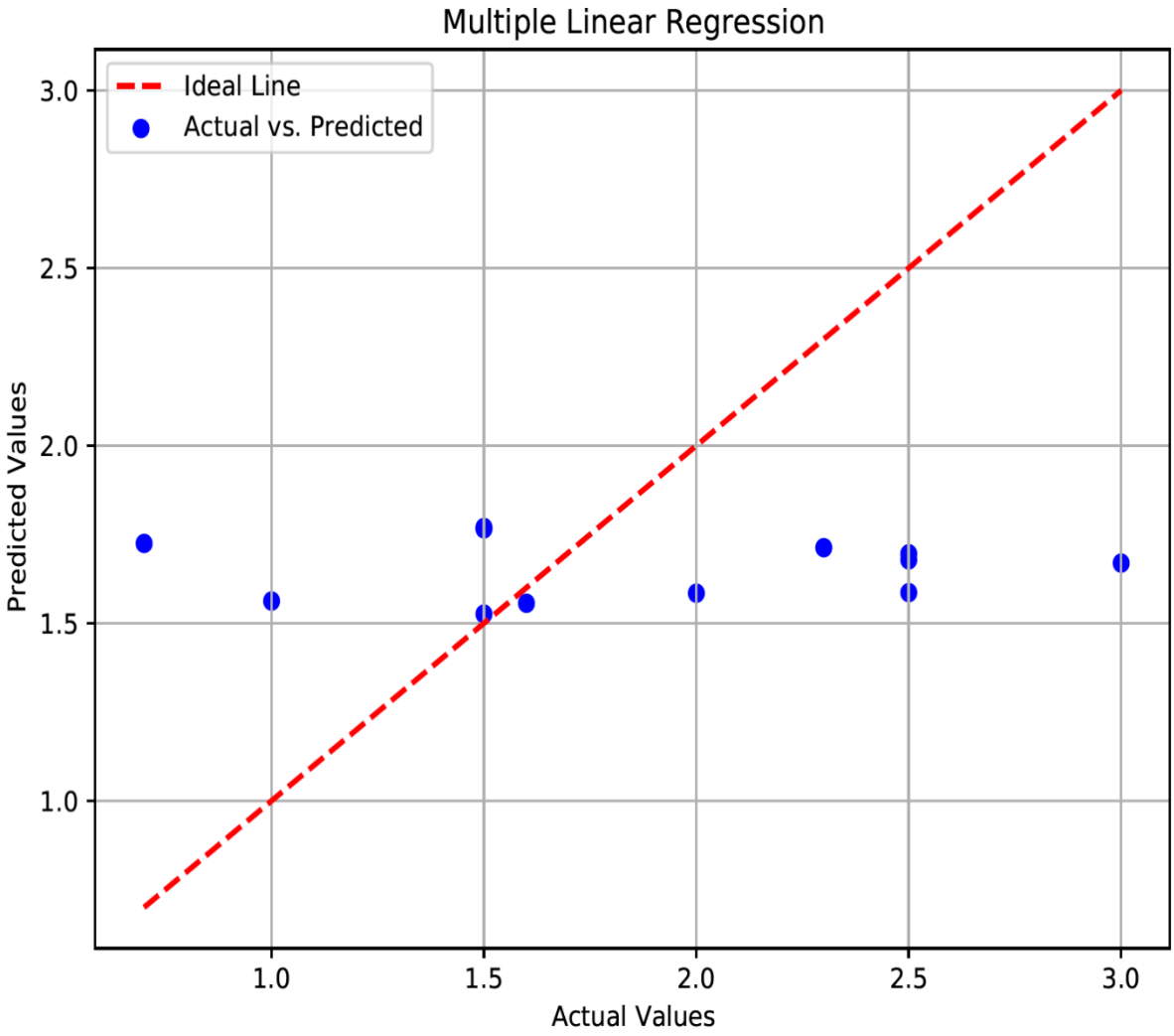


Figure 8: Multiple linear regression showing the relationship between gender, height, BMI, thyromental distance, and tracheal elongation. Actual versus predicted has no relationship with the ideal line (red line)

DISCUSSION

Unrecognized endotracheal tube malposition might have significant consequences in patients under general anesthesia. Earlier studies were primarily concerned with avoiding too-deep intubation. The hazards of shallow intubation were well known, but they were frequently neglected. Head and neck extension entails displacement of the tube towards the vocal cords. Our aim was to estimate this outward migration of ETT with respect to vocal cords, so that necessary adjustments to the depth of endotracheal tube placement may be made after head and neck extension.

The primary outcome of our study showed that with a neck extension of 30-40 degrees, on average, the ETT migrated outward at vocal cords by only 3 ± 0.3 mm. In the majority (*n*=32) of patients, the outward migration of the ETT at vocal cords was less than 5 mm, and in 5% of patients (*n*=3) only, the outward migration was more than 5 mm (10 mm in all three patients). In 19 patients, the ETT did not migrate at all due to head and neck extension.

The clinical implications of this finding guide the clinicians on how deep the ETT needs to be placed to prevent shallow intubation even in patients requiring intraoperative head and neck extension. With the head and neck in a neutral position, if an ETT is placed such that the cuff of ETT is at least 3 cm below the vocal cords, even with head and neck extension, in almost all cases, a 2 cm safe distance can be maintained between the vocal cords and the ETT cuff. Our study also describes this new technique of verifying the position of the intubation depth mark relative to the vocal cords. The main advantage of this technique is that irrespective of the mouth opening status, and position of the head and neck, too shallow intubation can be prevented.

Our study findings correlate with the latest study by Kang and colleagues[26] which measured saline-filled ETT cuff movement towards vocal cords with head and neck extension. They discovered that ETT outward movement at the vocal cords accounted for just 30% of the

increase in ETT tip-to-carina distance, with the remaining 70% attributed to tracheal elongation. However, they opined that the ultrasonic assessment of the laryngeal structures is challenging and is highly operator-dependent, which requires additional training.

Similarly, Wong and coworkers[23] measured the lengthening of the airway segments proximal and distal to vocal cords with head and neck extension. The lengthening of the airway segment distal to the vocal cords was (1.62 ± 0.7 cm) much greater than the distance from the upper incisor to the vocal cords (0.36 ± 0.7 cm). The findings of this study are consistent with our findings, although, unlike their study, our study participants were intubated using a nasotracheal tube.

Toung and colleagues[27] opined that head and neck extension causes a dramatic outward movement of the ETT at vocal cords as much as the change in the distance from the ETT tip to the carina. However, this was subsequently contradicted by other studies.[23,26]

The secondary outcomes of our study are to assess the optimal depth of the nasotracheal tube while maintaining a 3 cm distance between the vocal cords and the proximal end of the ETT cuff. This was found to be a mean of 26.2 ± 1.6 cm with head and neck in the neutral position and a mean of 26.5 ± 1.6 cm with head and neck in extension. The Chula formula[15], which was derived based on the study on Asian descent population is a commonly used height-based formula.

Chula formula for nasotracheal tube fixation (cm) = (height of patient in cm/10) + 9

As per the Chula formula, the mean depth of fixation of the nasotracheal tube was 25.5 ± 0.8 cm. In our study, we found that using the Chula formula, in 53% of patients (*n*=32), the distance between the vocal cords and the ETT cuff was between 1.2-2.0 cm even when the head and neck were in the neutral position. This is clinically an important finding as in these patients with head and neck extension the ETT cuff becomes overly shallow.

The vocal cord to carina distance with head and neck in neutral position was 12.1 ± 1 cm and with extension was 13.8 ± 1.1 cm. Overall the tracheal elongation was 1.7 ± 0.6 cm. This is consistent with the findings of Wong and colleagues[23], who found 1.62 ± 0.7 cm of tracheal elongation in their investigation.

The ETT tip-to-carina distance following neck extension was more than or equal to 2 cm in all 60 individuals in our study. Given this observation and the fact that shallow intubation was discovered in almost 50% of patients using the Chula formula[15], it may be desirable to secure ETT at a deeper level than advised by the Chula formula[15] in order to reduce the hazards of too shallow and endobronchial intubation.

A few things need to be considered while attempting to see the glottis in a patient under anesthesia. First, nasal cavities may be decongested by using vasoconstrictor nasal drops prior to introducing the FB. Second, a thorough pharyngeal suction should be performed before inserting the FB into the nose. Although adult FB has intrinsic suction ports, these ports have limited suction capability, and a preceding suction with a wide bore suction cuts down on the time needed to see the area of interest. Third, we occasionally encountered difficulties advancing the FB after it had passed the posterior nares. Under anesthesia, the upper airway muscles lose their tone and have a tendency to collapse, making it difficult to maneuver the FB to reach the glottis. At such times, the airway can be easily opened by a simple neck extension, a jaw-thrust, and/or a reverse Sellick maneuver, creating enough room for the FB to be advanced. Lastly, there are differing intubation guide marks provided by the manufacturers of the tracheal tube at the distal tip of the tube. We intubated all patients in our study with Rusch ETT as it has a circumferential 1 cm width black mark, which can be readily visualized (Figure 1). Endotracheal tubes of other manufacturers have a thin IDM, provided only on one side of the ETT. The operator of the FB should keep this in mind prior to moving the ETT outward in an attempt to visualize IDM to prevent accidental extubation.

STRENGTHS

The major strength of this study is the real-time assessment of ETT movement at the vocal cords with head and neck extension. Patients with craniofacial defects or other upper airway abnormalities, such as those with temporomandibular joint problems, or post-radiation treatment for head and neck cancer, were excluded from previous research due to potential difficulties with airway management. In these instances, it is more critical to ensure that the ETT is properly positioned. This study was conducted in patients with restricted mouth opening which, to our knowledge is the first of its kind.

In few studies, ultrasound was utilized to determine shallow ETT cuffs, but FB is necessary to diagnose overly deep intubation. In our study, both procedures were completed using a single device.

‘

LIMITATIONS AND FUTURE SCOPE

There are numerous limitations to our study. Firstly, we took approximately 8-12 minutes to take all the measurements discussed in the results. Thorough nasopharyngeal suction prior to introducing the FB is required in most cases. Secondly, the availability of the FB is mandatory for the study conduct. Thirdly, it is a single-center study with a small sample size.

In the future, large multicenter trials may be required before generalizing our study results to the general population.

SUMMARY AND CONCLUSIONS

In conclusion, we found that the ETT cuff moved toward the vocal cords during head and neck extension to a lesser extent than that of the tip moving away from the carina, reflecting a change in tracheal length. If an ETT is secured with its cuff 3 cm below the vocal cords in the neutral position, even after neck extension, it is likely that a 2 cm safe distance will be maintained between the ETT cuff and vocal cords.

We suggest using FB to assess the depth at the vocal cords in real-time after extending the head and neck to avoid ETT malpositioning and reduce the risks associated with overly shallow intubation. The nasotracheal tube may be fixed at a depth of 1 cm more than that suggested by the Chula formula.

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ANNEXURE I

PROFORMA

PATIENT DETAILS:

Name: Age: Sex:

UHID: Height: Weight:

BMI:

PREOPERATIVE PERIOD

Diagnosis: Surgery planned:

AIRWAY

Inter-incisor gap(cm): Mallampati class: Neck movements:

Thyromental distance: Nasal patency;

ETT size, company:

ET Tip to 3 cm black mark distance:

Proximal cuff to black guide mark distance:

Depth as per Chula formula:

Side of nasal cavity:

Depth of ETT when black mark is at VC (neutral):

Carina to ETT tip distance (neutral):

Measurement of head and neck extension:

Depth of ETT when black mark is at VC (extension):

Carina to ETT tip distance (extension):

Length of the trachea in neutral (distance of black mark from tip) + (tip to carina distance):

Length of the trachea in with extension + (tip to carina distance):

PATIENT INFORMATION SHEET

Dear Patient...

We are conducting an observational study at the All-India Institute of Medical Sciences, Bhopal to evaluate the amplitude of nasotracheal tube movement during head and neck extension in patients undergoing head and neck onco-surgeries.

Patient is invited to take part in the study. You are requested to go through the following paragraphs:

x) **Title of the study:** To measure the extent of endotracheal tube migration after placement of patient in optimal surgical position for primary head and neck onco-surgeries – A prospective, observational Study

ii) **Purpose of the study**: The aim of our study is to evaluate the optimal depth of nasotracheal tube at nose in patients undergoing head and neck cancer surgeries being performed at AIIMS, Bhopal.

iii) **Methodology**: A standard anaesthetic technique will be followed in all the patients included in the study. Written informed consent and thorough pre-anaesthetic evaluation will be done prior to recruiting patients. Patients undergoing head and neck cancer surgeries who require a breathing tube to be placed through the nose will be recruited. A breathing tube will be placed via nose either when the patient is awake or after the patient is anaesthetized. Then, to assess the adequacy of breathing tube depth, a device called fiber-optic bronchoscope will be used. Proper depth of the breathing tube will be maintained during head and neck in neutral position and during extension. Amplitude of breathing tube movement during head and neck extension will be noted.

iv) **Eligibility to participate in the study**: All patients aged 18-75 years with undergoing head and neck cancer surgeries who require a breathing tube to be placed through the nose will be eligible to participate in the study.

v) **Any risk to the subject associated with the study**: As this is a purely an observational study with no alteration of standard perioperative management, there is no identified risk associated with this study.

vi) **Confidentiality**: All the records will be confidential and the patient identity would be known to the chief investigator and would not be released to anybody else.

vii) **Provision of free treatment for research related injury**: No research related injury is expected and if any complication occurs, then participants are not liable for any compensation.

viii) **Freedom of individual to participate and to withdraw from research at any time without penalty or loss of benefits to which the subject would otherwise entitled:** Participation in the study is purely voluntary. Refusal to participate will not influence the care of the participants in this hospital in any way.

ix) **Costs and Source of investigations and drugs**: You will not be charged for anything related to this study project.

x) **Benefits:** There is no direct benefit for you from this study.

xi) **Available information sources:** The study is approved by the institute human ethics review board, AIIMS, Bhopal. Any query regarding the study can be clarified by contacting Dr. Seema (phone: 9652688582), principal investigator of the study.

All this information will be confidential and will not be disclosed to anybody.

Contact details of the ethics committee:

Dr. Shashank Purwar (Study independent person),

Member secretary,
IHEC-PGR,
AIIMS, Bhopal
Email: ihec@aiimsbhopal.edu.in
Contact no. +91 – 7773010099

रोगी सूचना पत्र

प्रिय रोगी...

हम अखिल भारतीय आयुर्विज्ञान संस्थान, भोपाल में एक अवलोकन अध्ययन कर रहे हैं ताकि सिर और गर्दन की ऑन्को-सर्जरी से गुजरने वाले रोगियों में सिर और गर्दन के विस्तार के दौरान नासोट्रेचियल ट्यूब की गति के आयाम का मूल्यांकन किया जा सके। रोगी को अध्ययन में भाग लेने के लिए आमंत्रित किया जाता है। आपसे अनुरोध है कि के माध्यम से जाएं निम्नलिखित पैराग्राफ:

x) अध्ययन का शीर्षक: प्राथमिक सिर और गर्दन की ऑन्को-सर्जरी के लिए इष्टतम सर्जिकल स्थिति में रोगी की नियुक्ति के बाद एंडोट्रैचियल ट्यूब प्रवास की सीमा को मापने के लिए – एक संभावित, अवलोकन संबंधी अध्ययन

ii) अध्ययन का उद्देश्य: हमारे अध्ययन का उद्देश्य एम्स, भोपाल में की जा रही सिर और गर्दन के कैंसर की सर्जरी कराने वाले रोगियों में नाक में नासोट्रैचियल ट्यूब की इष्टतम गहराई का मूल्यांकन करना है।

iii) कार्यप्रणाली: अध्ययन में शामिल सभी रोगियों में एक मानक संवेदनाहारी तकनीक का पालन किया जाएगा। रोगियों को भर्ती करने से पहले लिखित सूचित सहमति और संपूर्ण पूर्व-संवेदनाहारी मूल्यांकन किया जाएगा। सिर और गर्दन के कैंसर की सर्जरी कराने वाले मरीजों को भर्ती किया जाएगा, जिन्हें नाक के माध्यम से एक श्वास नली लगाने की आवश्यकता होती है। रोगी के जागने पर या रोगी को बेहोश करने के बाद नाक के माध्यम से एक श्वास नली लगाई जाएगी। फिर, श्वास नली की गहराई की पर्याप्तता का आकलन करने के लिए, फाइबर-ऑप्टिक ब्रोंकोस्कोप नामक एक उपकरण का उपयोग किया जाएगा। श्वास नली की उचित गहराई सिर और गर्दन के दौरान तटस्थ स्थिति में और विस्तार के दौरान बनाए रखी जाएगी। सिर और गर्दन के विस्तार के दौरान श्वास नली की गति के आयाम को नोट किया जाएगा।

iv) अध्ययन में भाग लेने की पात्रता: सिर और गर्दन के कैंसर की सर्जरी के दौर से गुजर के साथ 18-70 वर्ष की आयु के सभी रोगियों को जो नाक के माध्यम से रखा जा करने के लिए एक श्वास नली की आवश्यकता के साथ अध्ययन में भाग लेने के लिए पात्र होंगे ।

v) अध्ययन से जुड़े विषय के लिए कोई जोखिम: चूंकि यह मानक पेरिऑपरेटिव प्रबंधन में कोई परिवर्तन नहीं होने के साथ एक विशुद्ध रूप से एक अवलोकन अध्ययन है, इसलिए इस अध्ययन से जुड़ा कोई पहचाना जोखिम नहीं है ।

vi) गोपनीयता: सभी रिकॉर्ड गोपनीय होंगे और रोगी की पहचान मुख्य अन्वेषक को पता चल जाएगी और किसी और को जारी नहीं किया जाएगा ।

vii) अनुसंधान से संबंधित चोट के लिए मुफ्त उपचार का प्रावधान: कोई अनुसंधान से संबंधित चोट नहीं है अपेक्षित है और यदि कोई जटिलता होती है, तो प्रतिभागी किसी भी मुआवजे के लिए उत्तरदायी नहीं हैं।

viii) व्यक्ति की स्वतंत्रता में भाग लेने के लिए और दंड या लाभ की हानि है जो विषय अंयथा हकदार होगा बिना किसी भी समय अनुसंधान से वापस लेने के लिए: अध्ययन में भागीदारी विशुद्ध रूप से स्वैच्छिक है । भाग लेने से इनकार किसी भी तरह से इस अस्पताल में प्रतिभागियों की देखभाल को प्रभावित नहीं करेगा ।

ix) लागत और जांच और दवाओं के स्रोत: आप इस अध्ययन परियोजना से संबंधित कुछ के लिए शुल्क नहीं लिया जाएगा ।

x) लाभ: इस अध्ययन से आपके लिए कोई सीधा लाभ नहीं है।

ग्यारहवीं) उपलब्ध जानकारी सूत्रों: अध्ययन संस्थान मानव नैतिकता समीक्षा बोर्ड, एम्स, भोपाल द्वारा अनुमोदित है । अध्ययन के संबंध में किसी भी प्रश्न को अध्ययन की प्रमुख अन्वेषक डॉ सीमा (फोन: 9652688582) से संपर्क करके स्पष्ट किया जा सकता है ।

यह सारी जानकारी गोपनीय होगी और इसका खुलासा किसी को नहीं किया जाएगा।

आचार समिति के संपर्क विवरण:

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INFORMED CONSENT FORM

Full Study Title: To measure the extent of endotracheal tube migration after placement of patient in optimal surgical position for primary head and neck onco-surgeries – A prospective, observational study

1. I confirm that I have read and understood the patient information sheet for the study. I confirm that the study has been explained to me and I have had ample time and opportunity to ask questions.	[ ]
2. I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.	[ ]
3. I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s)	[ ]

I confirm that I have fully explained all aspects of the trial to the subject (or legally acceptable representative)

Signature of the person conducting the Informed Consent

_____	_____	____/___/_____
Name of the Study Investigator	Signature of the Study Investigator	Date Month Year

Name of the participant _____ Signature of the participant

सूचित सहमति प्रपत्र

पूर्ण अध्ययन शीर्षक: प्राथमिक सिर और गर्दन onco-सर्जरी के लिए इष्टतम शल्य चिकित्सा स्थिति में रोगी की नियुक्ति के बाद एंडोट्रेक्सील ट्यूब माइग्रेशन की सीमा को मापने के लिए -एक संभावित, अवलोकन अध्ययन

1. मैं पुष्टि करता हूं कि मैंने अध्ययन के लिए रोगी सूचना पत्र को पढ़ा और समझा है। मैं इस बात की पुष्टि करता हूं कि अध्ययन मुझे समझाया गया है और मुझे प्रश्न पूछने के लिए पर्याप्त समय और अवसर मिला है ।	[ ]
2. मैं समझता हूं कि अध्ययन में मेरी भागीदारी स्वैच्छिक है और मैं किसी भी समय वापस लेने के लिए स्वतंत्र हूं, किसी भी कारण दिए बिना, मेरी चिकित्सा देखभाल या कानूनी अधिकारों को प्रभावित किया जा रहा बिना ।	[ ]
3. मैं इस अध्ययन से उत्पन्न होने वाले किसी भी डेटा या परिणामों के उपयोग को प्रतिबंधित नहीं करने के लिए सहमत हूं बशर्ते ऐसा उपयोग केवल वैज्ञानिक उद्देश्य के लिए हो (ओं)	[ ]

मैं पुष्टि करता हूं कि मैंने इस विषय पर परीक्षण के सभी पहलुओं को पूरी तरह से समझाया है (या कानूनी रूप से स्वीकार्य प्रतिनिधि)
सूचित सहमति का संचालन करने वाले व्यक्ति के हस्ताक्षर

_____ _____ ____/___/_____

अध्ययन अन्वेषक का नाम | अध्ययन अन्वेषक के हस्ताक्षर | तिथि माह वर्ष

प्रतिभागी का नाम | प्रतिभागी के हस्ताक्षर

MASTER CHART – 1

S. no	Age	Sex	UHID	Diagnosis	Surgery	Ht	Wt	BMI	MO	TMD	ETT size	TTIDM	cD	Side	nD	nTTCD	eD	eTTCD	nVCCD	eVCCD	MG	tEL
1	35	F	2.39212E+14	MM L LA	WLE + Margn Rvsn	155	40	16.649	1.5	5.5	6	8.5	24.5	left	24	2.5	24.5	5	11	13.5	5	2.5
2	50	M	2.39212E+14	Ca L LA	L HM+SOND+PMMC flap	168	60	21.259	1.2	7	6.5	9.5	25.8	right	25	4.1	25.5	5.3	13.6	14.9	5	1.3
3	74	M	2.39212E+14	Ca L BM	WLE+SM+PMMC flap	165	72	26.446	1.4	8	8	10	25.5	right	26	3.2	26	5	13.2	15	0	1.8
4	52	M	2.39212E+14	SCC R lip	WLE + R MRND	170	70	24.221	1.5	7	7	9.5	26	left	24.5	2.7	25	5	12.2	14.5	5	2.3
5	39	F	2.39212E+14	Ca L BM	WLE + L MRND	145	38	18.074	1.3	7.5	6.5	9	23.5	right	22	2.7	22.5	4	11.7	13	5	1.3
6	42	M	2.39212E+14	Ca L LA	L HM ND	167	58	20.797	1.2	7.5	7	9.5	25.7	right	26	2.5	26.3	4.8	12	14.3	3	2.3
7	43	M	2.39212E+14	Ca R BM	WLE + ND + PMMC	165	63	23.14	1.1	8	7	9.5	25.5	left	25	2.8	25.3	4.5	12.3	14	3	1.7
8	45	M	2.39212E+14	Ca L BM	WLE + ND + PMMC	168	75	26.573	1	7	7	9.5	25.8	right	25	3	26	5	12.5	14.5	10	2
9	48	F	2.39212E+14	Ca R LA	WLE+ ND + PMMC	152	50	21.641	1.5	6.5	6.5	9	24.2	right	25	1.2	25	4.2	10.2	13.2	0	3
10	49	M	2.39212E+14	Ca L BM	WLE + ND + PMMC flap	170	62	21.453	1.4	6.5	7	9.5	26	right	27.5	4	28	4.8	13.5	14.3	5	0.8
11	60	F	2.39212E+14	Ca R BM	WLE + ND+ prim closure	153	54	23.068	1.2	6.5	6.5	9	24.3	right	24	2.3	24.3	3.5	11.3	12.5	3	1.2
12	55	F	2.39212E+14	Ca L BM	WLE + SOBD	154	52	21.926	1.4	6.7	6.5	9	24.4	right	22.5	4	23	6.5	13	15.5	5	2.5
13	38	M	2.39212E+14	Ca L BM	WLE + MRND	169	52	18.207	1.5	7	6.5	9	25.9	right	26	3.5	26.5	5	12.5	14	5	1.5
14	48	M	2.39212E+14	VCA R LA	WLE + RECON	167	53	19.004	1.5	6.5	7.5	10	25.7	left	27	2.5	27.5	3.2	12.5	13.2	5	0.7
15	39	M	2.39212E+14	Ca L BM	WLE+ ND + PMMC	159	67	26.502	1.2	7	7	9.5	24.9	left	26	1	26.5	3.5	10.5	12.5	5	2
16	37	M	2.39212E+14	Ca L BM	WLE + RECON	169	48	16.806	1.3	7.5	7	9.5	25.9	right	26	4	26.2	6	13.5	15.5	2	2
17	28	M	2.39212E+14	Ca R BM	WLE + MRND + PMMC	168	55	19.487	1.2	7.5	7.5	10	25.8	left	27	2.5	27.5	4.5	12.5	14.5	5	2
18	55	M	2.39212E+14	Ca R BM	WLE + ND	175	60	19.592	1.1	7	6.5	9	26.5	left	28	2.2	28	3.5	11.2	12.5	0	1.3
19	42	M	2.39212E+12	Ca L BM	WLE+MRND+prim closure	169	57	19.957	1.4	7.5	7	9.5	25.9	right	27	2	27.2	4	11.5	13.5	2	2
20	69	M	2.39212E+14	Ca R BM	WLE+SOHBD+SM+PMMC	172	65	21.971	1.5	7	7.5	10	26.2	right	28	3.3	28	4.2	13.3	14.2	0	0.9
21	57	F	2.39212E+14	VCA R BM	WLE+SOHND+Prim closure	158	52	20.83	1.3	7	6.5	9	24.8	left	26	3.2	26.2	4.5	12.2	13.5	2	1.3
22	44	M	2.39212E+14	Ca R LA	WLE+MM+MRND	183	70	20.902	1.2	7.5	7.5	10	27.3	right	28	3.2	28.2	5	13.2	15	2	1.8
23	33	M	2.39212E+14	Ca R BM	WLE + MRND + PMMC	170	60	20.761	1.1	6.5	7	9.5	26	left	26.5	4	26.8	5.3	13.5	14.8	3	1.3
24	55	F	2.39212E+14	Ca L BM	WLE + ND	155	55	22.893	1.4	6.5	6.5	9	24.5	right	23	0.8	23.2	2.4	9.8	11.4	2	1.6
25	32	M	2.39212E+14	Ca L BM	WLE + MRND + PMMC	170	62	21.453	1.5	7.5	7	9.5	26	right	27	2.3	27	3.5	11.8	13	0	1.2
26	69	F	2.39212E+14	Ca L BM	WLE + MRND + PMMC	147	59	27.303	1.4	7	6.5	9	23.7	right	24	2.5	24	3.5	11.5	12.5	0	1
27	35	M	2.39212E+14	Ca L BM	WLE + ND	183	68	20.305	1.2	7.5	7	9.5	27.3	right	29	2.3	29	4	11.8	13.5	0	1.7
28	51	M	2.39212E+14	Ca R Up lip	WLE+SOHND+Prim closure	165	60	22.039	0.9	7	7.5	10	25.5	left	26.5	2	27.5	4.5	12	14.5	10	2.5
29	47	M	2.39212E+14	Ca R BM	WLE + MRND + PMMC	168	52	18.424	1	7	7.5	10	25.8	left	27	2	27.5	4.2	12	14.2	5	2.2
30	45	M	2.39212E+14	Ca L BM	WLE+SOBD+RFFF	175	60	19.592	1.1	7	7.5	10	26.5	left	28	3.6	28.5	4.5	13.6	14.5	5	0.9

BM- buccal mucosa; BMI – body mass index in $kg.cm^{-2}$; cD – depth of intubation as per Chula formula; eD - head and neck extended position: depth of intubation after aligning IDM with vocal cords; vocal cord to carina distance; ETT – endotracheal tube size in mm; eTTCD - head and neck extended position: ETT tip to carina distance; eVCCD - head and neck extended position: vocal cord to carina distance; HM- hemimandibulectomy; Ht – height in cm; L – left; LA-lower alveolus; MG – outward migration of the ETT at vocal cords; MM- marginal mandibulectomy; MRND- modified radical neck dissection; ND- neck dissection; nD – neutral head and neck position: depth of intubation after aligning IDM with vocal cords; nVCCD - neutral head and neck position: vocal cord to carina distance; PMMC- pectoralis major myocutaneous flap; nTTCD – neutral head and neck position: ETT tip to carina distance; R- right; RFFF- radial forearm free flap; SCC- squamous cell carcinoma; SM- segmental mandibulectomy; side – side of intubation; SOBD – supraomohyoid block dissection; SOHND- supraomohyoid neck dissection; tEL – tracheal elongation due to head and neck extension; TMD – Thyromental distance; TTIDM – distance from ETT tip to intubation depth mark (IDM); VCA- verrucous carcinoma; WLE – wide local excision; Wt – Weight in Kg;

MASTER CHART – 2

S. no	Age	Sex	UHID	Diagnosis	Surgery	Ht	Wt	BMI	MO	TMD	ETT size	TTIDM	cD	Side	nD	nTTCD	eD	eTTCD	nVCCD	eVCCD	MG	tEL
31	41	M	2.39212E+14	Ca R BM	WLE+MRND+DP+PMMC	165	58	21.304	1.5	7	6.5	9	25.5	right	27	4	27	5.5	13	14.5	0	1.5
32	38	M	2.39212E+14	Ca R BM	WLE+Comp res+flap	168	62	21.967	1.4	7	7	9.5	25.8	right	27	4	27.5	6	13.5	15.5	5	2
33	33	M	2.39212E+14	Ca R BM	WLE+MRND+primary closu	180	60	18.519	1.5	7.5	7.5	10	27	left	28.5	3.5	28.5	4.8	13.5	14.8	0	1.3
34	40	F	2.39212E+14	Ca L LA	WLE + MRND	165	55	20.202	1.4	6.5	7	9.5	25.5	right	27	1	27	2	10.5	11.5	0	1
35	37	M	2.39212E+14	Ca R BM	WLE+MM+SOBND+NLF	156	58	23.833	1	7.5	7	9.5	24.6	right	26	1	26	2	10.5	11.5	0	1
36	45	M	2.39212E+14	Ca L BM	WLE+MRND+SM+PMMC	165	60	22.039	1.3	7	7	9.5	25.5	left	27	2.5	27	4	12	13.5	0	1.5
37	38	M	2.39212E+14	Ca R BM	MM+MRND+Prim closure	167	62	22.231	1.2	7	7.5	10	25.7	left	26	1	26.5	4	11	14	5	3
38	54	M	2.39212E+14	Ca R LA	WLE+MM+SOBD	178	65	20.515	1.1	7.5	7.5	10	26.8	right	28.5	1.5	28.5	3	11.5	13	0	1.5
39	52	M	2.39212E+14	Ca R BM	WLE + PMMC Flap cover	165	60	22.039	1	7	7.5	10	25.5	left	27	1	27.5	4.5	11	14.5	5	3.5
40	43	M	2.39212E+14	Ca R BM	WLE + Right SOHND	163	60	22.583	1.5	7	7.5	10	25.3	Right	27	2.5	27.5	4.5	12.5	14.5	5	2
41	61	F	2.39212E+14	Ca R BM	WLE+MRND	157	58	23.53	1.3	6.5	6.5	9	24.7	right	25.5	3	26	4.5	12	13.5	5	1.5
42	56	M	2.39212E+14	Ca R LA	WLE+MRND+SM+PMMC	166	65	23.588	1.2	7.5	7	9.5	25.6	left	27	3.5	27	5	13	14.5	0	1.5
43	57	M	2.39212E+14	Ca R BM	WLE + ND	168	68	24.093	1.5	7.5	7.5	10	25.8	right	27.5	2.8	28	4.5	12.8	14.5	5	1.7
44	39	M	2.39212E+14	Ca R BM	WLE + MRND	167	65	23.307	1.4	7	7.5	10	25.7	left	27	1.5	27	3	11.5	13	0	1.5
45	59	F	2.39212E+14	Ca R BM	WLE+ND+ primary closure	154	54	22.769	1.2	6.5	6.5	9	24.4	right	24	2.3	24.3	3.5	11.3	12.5	3	1.2
46	54	F	2.39212E+14	Ca L BM	WLE + SOBD	153	52	22.214	0.9	7	6.5	9	24.3	right	22.5	4	23	6.5	13	15.5	5	2.5
47	34	M	2.39212E+14	Ca L LA	WLE + MRND	168	52	18.424	1.4	7	6.5	9	25.8	right	26	3.5	26.5	5	12.5	14	5	1.5
48	49	M	2.39212E+14	VCA R LA	WLE + reconstruction	165	53	19.467	1.1	6.5	7.5	10	25.5	left	27	2.5	27.5	3.2	12.5	13.2	5	0.7
49	40	M	2.39212E+14	Ca L BM	WLE+ND+PMMC	160	67	26.172	1.5	7	7	9.5	25	left	26	1	26.5	3.5	10.5	12.5	5	2
50	36	M	2.39212E+14	Ca L BM	WLE + reconstruction	168	48	17.007	1.4	7.5	7	9.5	25.8	right	26	4	26.2	6	13.5	15.5	2	2
51	58	F	2.39212E+14	Ca L BM	WLE + Neck dissection	154	55	23.191	1.2	7	6.5	9	24.4	right	23	0.8	23.2	2.4	9.8	11.4	2	1.6
52	33	M	2.39212E+14	Ca L BM	WLE + MRND + PMMC	169	62	21.708	1.1	7.5	7	9.5	25.9	right	27	2.3	27	3.5	11.8	13	0	1.2
53	70	F	2.39212E+14	Ca L BM	WLE + MRND + PMMC	148	59	26.936	1.4	7	6.5	9	23.8	right	24	2.5	24	3.5	11.5	12.5	0	1
54	38	M	2.39212E+14	Ca L BM	WLE + Neck dissection	180	68	20.988	1.5	7.5	7	9.5	26.7	right	28.5	2.3	28.5	4	11.8	13.5	0	1.7
55	50	M	2.39212E+14	Ca R Up lip	WLE+SOHND+Prim closure	166	60	21.774	1.3	7	7.5	10	25.6	left	26.5	2	27.5	4.5	12	14.5	10	2.5
56	49	M	2.39212E+14	Ca R BM	WLE+MRND+PMMC	167	52	18.645	1.2	7	7.5	10	25.7	left	27	2	27.5	4.2	12	14.2	5	2.2
57	41	M	2.39212E+14	Ca R BM	WLE + Right SOHND	164	60	22.308	1.1	7	7.5	10	25.4	Right	27	2.5	27.5	4.5	12.5	14.5	5	2
58	63	F	2.39212E+14	Ca R BM	WLE + MRND	156	58	23.833	1.5	6.5	6.5	9	24.6	right	25.5	3	26	4.5	12	13.5	5	1.5
59	58	M	2.39212E+14	Ca R LA	WLE+MRND+SM+PMMC	167	65	23.307	1.5	7	7	9.5	25.7	left	27	3.5	27	5	13	14.5	0	1.5
60	55	M	2.39212E+14	Ca L BM	WLE + ND	170	68	23.529	1.4	7.5	7.5	10	26	right	27.5	2.8	28	4.5	12.8	14.5	5	1.7

BM- buccal mucosa; BMI – body mass index in $kg.cm^{-2}$; cD – depth of intubation as per Chula formula; eD - head and neck extended position: depth of intubation after aligning IDM with vocal cords; vocal cord to carina distance; ETT – endotracheal tube size in mm; eTTCD - head and neck extended position: ETT tip to carina distance; eVCCD - head and neck extended position: vocal cord to carina distance; HM- hemimandibulectomy; Ht – height in cm; L – left; LA-lower alveolus; MG – outward migration of the ETT at vocal cords; MM- marginal mandibulectomy; MRND- modified radical neck dissection; ND- neck dissection; nD – neutral head and neck position: depth of intubation after aligning IDM with vocal cords; nVCCD - neutral head and neck position: vocal cord to carina distance; PMMC- pectoralis major myocutaneous flap; nTTCD – neutral head and neck position: ETT tip to carina distance; R- right; RFFF- radial forearm free flap; SCC- squamous cell carcinoma; SM- segmental mandibulectomy; side – side of intubation; SOBD – supraomohyoid block dissection; SOHND- supraomohyoid neck dissection; tEL – tracheal elongation due to head and neck extension; TMD – Thyromental distance; TTIDM – distance from ETT tip to intubation depth mark (IDM); VCA- verrucous carcinoma; WLE – wide local excision; Wt – Weight in Kg;